Sun, Sand, Surf and Science

Hawaii–a world model for clean energy.

The Hawaii Clean Energy Initiative

The State of Hawaii and the U.S. Department of Energy (DOE) signed a Memorandum of Understanding (MOU) to establish the *Hawaii Clean Energy Initiative*. This unprecedented partnership is intended to make Hawaii a clean energy model for the United States. Under the MOU, Hawaii will explore using a greater variety of renewable energy technologies including wind, sun, ocean, geothermal, and bioenergy. The goal is to have renewable sources provide at least 70% of the state's energy needs by 2030 and includes major use of energy efficiency.

Efforts will focus on working with public and private partners on several clean energy projects including:

- Integrating renewable energy, including solar, wind, energy storage and advanced vehicle technologies into existing systems to meet the islands' energy needs.
- Expanding Hawaii's capability to use locally grown crops as byproducts for producing fuel and electricity.
- Developing comprehensive energy regulatory and policy frameworks to promote clean energy technology use.

Discover why high-tech companies around the globe are relocating and investing in Hawaii.

- Unprecedented incentives for technology businesses:
  - 100% tax credit on investments up to $2 million per company, per year – more than double offered by any other state.
  - Any company conducting 50% or more of its total activities in research and development work, computer software programming and biotechnology qualifies for tax credits.
  - Refundable research and development income tax credit, reducing the investment risk in Hawaii for companies conducting research.
  - Proceeds from royalties, patents, and copyrights are exempt from state tax.
  - Stock options are exempt from capital gains and income tax. The stock option income tax exclusion also applies to stock options issued by the holding company and is valid for equity interests in entities other than corporations.
  - General excise tax (GET) and public service company tax exemptions for Public Internet Data Centers. The GET exemption also applies to IT services, database management services and the use of software and hardware.

  Go to www.hitechhawaii.com/taxincentives.asp for more information.

- The high solar insolation, brisk trade winds, and deep coastal waters make Hawaii a great test laboratory for renewable applications.
- Strategic Mid-Pacific Location: Hawaii is an international hub for trans-Pacific fiber and satellite communications networks. Hawaii is the most wired state in the nation.
- Strategic time zone: Only state in the nation able to communicate with New York, Washington D.C., Hong Kong, Japan and Singapore within the same business day.
- World-Class infrastructure:
  - University of Hawaii (www.hawaii.edu)
    - ➤ University of Hawaii at Manoa - College of Tropical Agriculture & Human Resources (www.ctahr.hawaii.edu/ctahr2001)
    - ➤ University of Hawaii at Manoa - Hawaii Natural Energy Institute (www.hnei.hawaii.edu)
    - ➤ University of Hawaii at Hilo - College of Agriculture, Forestry and Natural Resource Management (www.uhh.hawaii.edu/academics/cafnrm)
    - ➤ Maui Community College - Sustainable Living Institute of Maui (http://sustainablemaui.com/isisa.html)
  - Hawaii Agriculture Research Center (www.hawaiiag.org/harc)
  - Hawaii Center for Advanced Transportation Technologies (www.htdc.org/hcatt)
  - Maui Research & Tecnology Center (www.htdc.org/incubation/mrtc)
  - Pacific International Center for High Technology Research (www.pichtr.org)
  - Natural Energy Laboratory of Hawaii Authority (www.nelha.org)

Business Support

Department of Business, Economic Development & Tourism

The core mission of the Department of Business, Economic Development & Tourism (DBEDT) is to strengthen and diversify Hawaii's economy, lead business development efforts, attract new businesses and investment, and document Hawaii's economic development.

DBEDT operates a variety of programs to address small business issues, market the State's products and services, promote Hawaii as a place to do business, assist in the development of strategic industries, and identify new economic opportunities to benefit the people of Hawaii. (808) 586-2423, www.hawaii.gov/dbedt

Other business resources include:

High Technology Development Corporation

Offers business assistance to companies interested in investing, expanding or relocating in Hawaii. Operates three incubation facilities, a technical assistance program for small businesses participating in federal research and development funding programs, a high technology web portal, and a statewide incubation services program. (808) 539-3806, www.htdc.org

Economic Development Organizations

Dedicated to attracting, retaining and growing business in Hawaii. Collaborate with government agencies and other business associates.

- Enterprise Honolulu
  1-877-423-6332, www.enterprisehonolulu.com
- Maui Economic Development Board
  (808) 875-2300, www.medb.org
- Kauai Economic Development Board
  (808) 245-6692, www.kedb.com
- Hawaii Island Economic Development Board
  (808) 935-2180, www.hiedb.org

National Defense Center of Excellence for Research in Ocean Sciences

Supports the Department of Defense technology requirements; encourages leading edge research and development (R&D) in ocean sciences and technology in Hawaii; and fosters the use of ocean R&D facilities in Hawaii. (808) 327-4310, www.ceros.org

Aquaculture Development Program

Located within the Hawaii Department of Agriculture, the Aquaculture Development Program, assists new and on-going aquaculture ventures. The program provides business counseling, offers marketing assistance, delivers animal health management services, and supports research and extension activities. (808) 587-0030, www.hawaiiaquaculture.org

Hawaii Strategic Development Corporation

Promotes economic development and diversification, in conjunction with private enterprise. Dedicated to developing a sustainable venture capital industry in Hawaii. (808) 587-3829, www.htdc.org/hsdc

Hawaii Science & Technology Council

An industry association serving Hawaii companies engaged in a variety of tech sectors. (808) 536-4670, www.hiscitech.org

Hawaii Venture Capital Association

Fosters entrepreneurial development through networking, education and access to venture capital. (808) 262-7329, www.hvca.org

Natural Energy Laboratory of Hawaii Authority

Provides resources and facilities for energy and ocean-related research, educational, and commercial activities. (808) 329-7341, www.nelha.org

University of Hawaii's Office of Technology Transfer and Economic Development

Markets and licenses technologies developed at the University of Hawaii; seeks to encourage broad utilization of the results of University research; and supports the transfer of new technology and ideas from the University to the community-at-large. (808) 539-3819, www.mic.hawaii.edu

Hawaii Department of Business, Economic Development & Tourism

Strategic Industries Division

P.O. Box 2359, Honolulu, Hawaii 96804
Telephone: (808) 587-3809
Fax: (808) 587-3820
www.hawaii.gov/dbedt

05-2008

Sustainable Energy

Hawaii

Technology in Paradise

Look beyond Hawaii's pristine beaches and you'll discover an emerging technology industry, supported by innovative business initiatives and competitive advantages unique to the Islands.

Hawaii's Energy for Tomorrow

1 BIOENERGY

- Design and optimization of thermal, chemical and biological processes for fuels production from biomass.
- Development of crops, microbial systems and enzymes for bioenergy.

2 WIND POWER

- Patented Electronic Shock Absorber developed to minimize voltage variations from wind power.
- Data collection and analysis of wind turbine and hybrid systems performance.

3 PHOTOVOLTAICS

- Data collection and analysis on performance of solar arrays, inverters and batteries; commercial operation of hybrid systems.
- Patented multijunction hybrid photoelectrodes.
- Implementation of Renewable Energy Service Companies for remote rural locations; renewable energy training.

4 GEOTHERMAL

- Hawaii's first geothermal plant taps deep into Hawaii Island.
- State-of-the-art technology converts steam into electricity.
- Produces 20% of Hawaii Island's electricity needs.

5 LEADERSHIP IN GREEN BUILDING

- LEED® certified buildings.
- ENERGY STAR® program.

6 OCEAN ENERGY

- World's first production of net electrical power from OTEC.
- Design and operation of world's only open-cycle OTEC system.
- World leader in design and installation of deep-sea pipelines.
- Design, testing, fabrication and sea trials of wave energy devices.

7 ADVANCED TRANSPORTATION TECHNOLOGIES

- Facility for electric, hybrid, and fuel cell vehicle assembly, repair, maintenance; testing and rapid recharging.
- Computational fluid dynamics techniques to study battery performance; research into battery processes.

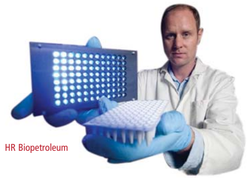
8 HYDROGEN TECHNOLOGIES

- Characterization of fuel cell performance and reliability.
- Testing & Development of fuel cells, vehicles & hydrogen fueling station.
- Developed first fuel cell powered vehicle in State of Hawaii: 30-ft bus.

1

Pacific Biodiesel Technologies

Pacific Biodiesel was established in 1996 to convert the unmanageable quantity of used cooking oil being dumped in Maui's central landfill into biodiesel, an environmentally-friendly alternative to petroleum diesel. Today, with experience gained from over 10 years of building and operating biodiesel plants internationally, Pacific Biodiesel's vision is to create truly sustainable, community-based biodiesel facilities, which incorporate feedstock production, fuel processing and product distribution within localized areas. Pacific Biodiesel is getting ready for another expansion, set for Spring 2008 in Salem, OR, with green supporter and investor, Willie Nelson.



HR Biopetroleum

HR Biopetroleum formed a joint venture with Royal Dutch Shell plc for the construction of a pilot facility to grow marine algae to produce vegetable oil for conversion into biofuel. The open-air pond facility will only grow non-modified, marine microalgae species indigenous to Hawaii or approved by the Hawaii Department of Agriculture. Algae holds great promise for plant-based fuels due to their rapid growth, high yield on land unusable for food crops, and potential to absorb or 'capture' waste CO2.

Scientists at the **Hawaii Natural Energy Institute** at the University of Hawaii have patented a process called Flash Carbonization,™ which quickly and efficiently produces charcoal from various kinds of biomass. The Flash Carbonization™ technology has been licensed to several US companies including the Kingsford Products Company, the world's largest manufacturer of barbecue products.

Hawaii Natural Energy Institute

Gay & Robinson, Inc.

Hawaii's first ethanol plant is being developed by **Gay & Robinson Ag-Energy LLC**, a new partnership between Kauai's Gay & Robinson Inc., which operates a 7,500 acre sugar cane plantation and sugar mill on Kauai, producing approximately 50,000 tons of sugar per annum and Pacific West Energy LLC, a worldwide developer of renewable energy projects with offices in Kauai and Vancouver. The initial phase will include installation of a new biomass boiler and turbine generator to efficiently produce renewable electricity. Future plans call for biodiesel production, a methane recovery system, the processing of municipal solid waste, hydropower and solar energy production.

2

Reliable, strong, and steady tradewinds make certain locations in Hawaii among the nation's best for wind-generated electricity. On Maui, the **Kaheawa Power Project** generates enough power to meet 9% of Maui's electricity need during peak hours, and up to 30% during non-peak hours. Several wind farms are located on Hawaii Island. Tawhiri Power LLC's wind turbines at **Pakini Nui Wind Farm**, the **Hawi Renewable Development at Upolu Point Wind Farm** and the **Lalamilo Wind Farm**, owned by Hawaii Electric Light Company (HELCO), collectively save approximately 200,000 barrels of oil per year.

UPC Hawaii Wind Partners, LLC

3

Mauna Lani Resort

The **Mauna Lani Resort** on Hawaii Island has the most photovoltaic (PV) solar panels of any resort in the world, providing 620 kW from rooftop systems on the hotel and golf course, and a 2.5 acre ground-mounted tracking system at the well water pumping facility. The hotel array provides power to operate all six floors during peak solar production. The golf water system pumps over 3 million gallons of water per day and waters 38 golf holes. More than 50% of the electricity required by the golf operation is provided by solar.

At **Pearl Harbor**, the Navy purchased the 309kW PowerGuard solar electric rooftop system to make innovative use of an empty, pre-World War II aircraft hanger rooftop, on Ford Island. The array covers 31,000 square feet of roof space and incorporates 1,545 solar panels. This project was made possible through a joint venture between industry and the Navy, with federal funding obtained through Hawaii's Congressional Delegation.

Parker Ranch, Inc.

Founded in 1847, **Parker Ranch,** on Hawaii Island, is one of the oldest ranches in the United States and at about 150,000 acres, among the largest. Their breakthrough energy project, "Ranching the Sun" was once the world's largest hybrid solar energy project, converting sun and wind into electricity. The project generates more than 90% of the daytime electrical power needed to provide drinking water for ranch livestock.

4

Puna Geothermal Venture, An Ormat Company

Puna Geothermal Venture (PGV) on Hawaii Island, one of the state's most reliable renewable energy sources, has been quietly producing geothermal-generated electricity for Hawaii Electric Light Company for 15 years, producing approximately 20% of the Big Island's electricity consumption and displacing 144,000 barrels of oil annually. Since becoming part of Ormat Technologies Inc., a company with considerable geothermal experience, Hawaii's only commercial producer of geothermal energy has undergone substantial upgrades. PGV's 30-megawatt low-profile plant uses air-cooled condensers and noise reduction enclosures, and has near zero emissions. One hundred percent of the geothermal fluid and gas is reinjected into the deep earth.

5

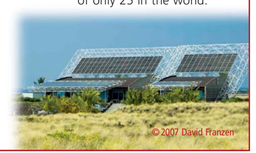
Taking advantage of opportunities provided by Hawaii's climate, State government has used energy efficient designs to develop several **Leadership in Energy and Environmental Design** (**LEED®**) certified buildings. LEED, the nationally recognized building standard developed by the U.S. Green Building Council, promotes high-efficiency buildings. Hawaii also participates in the ENERGY STAR® Program, which identifies the most energy-efficient buildings in the nation. Hawaii ranks fifth in the nation in total energy cost savings for ENERGY STAR buildings, which use about 30% less energy than average.

Thomas D. Van Liew

Courtesy of Punahou School

A private sector building earning LEED certification is **Punahou School's Case Middle School**. The 130,000-square-foot, nine-building complex earned a Gold certification – one of only 7 school projects in the nation to receive this distinguished recognition.

The **Natural Energy Laboratory of Hawaii Authority** (**NELHA**) operates an innovative ocean science and technology park on Hawaii Island. Using the sun and the sea, NELHA brings economic development and diversification to Hawaii. The **Hawaii Gateway Energy Center** at NELHA, provides the setting for research and development in distributed energy resources and renewable energy technologies by companies such as **Sopogy**. The Center is the recipient of a LEED platinum designation award – one of only 25 in the world.



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6

Makai Ocean Engineering, Inc.

Makai Ocean Engineering, Inc. designed the world's first commercial deep Sea Water Air-Conditioning system (SWAC) at the InterContinental Bora Bora Resort and Thalasso Spa. This technology involves deep-water pipelines, which provide frigid pure lake or seawater to shore for a cost-effective centralized air conditioning system. **Honolulu Seawater Air Conditioning LLC**, has received the equity funding required to embark on the design and environmental impact statement phases of a 25,000-ton seawater air conditioning district cooling system for downtown Honolulu. The state legislature approved $100 million in special purpose revenue bonds for the project.

Hawaii's advantages as a wave energy test site were employed by **Ocean Power Technologies, Inc.** OPT is commercializing its Power Buoy system, after testing in Kaneohe Bay on Oahu.

In 1979, the **State of Hawaii** achieved the world's first net production of electricity using closed-cycle Ocean Thermal Energy Conversion (OTEC) aboard *Mini-OTEC*, a converted Navy barge, in the waters off Hawaii Island. The OTEC process utilizes potential energy from a natural temperature difference of about 20° C between cold deep and warm surface seawater, available throughout the year in Hawaii. With no continental shelf, Hawaii's steep offshore bathymetry provides easy access to the deep cold water. Rising oil prices have generated a renewed interest in OTEC and several Hawaii companies are pursuing OTEC projects in Hawaii and around the world.

Navatek Ltd.

Navatek Ltd. is using the experience gained from designing advanced ship hull forms for the U.S. Navy to develop a patent-pending wave energy conversion (WEC) device that uses simple, robust, low-tech industrial parts, captures energy over a large range of wave heights, is scalable, and can efficiently operate in the marine environment with no external servicing for prolonged periods.

7

The **National Demonstration Center for Alternative Fuel Vehicles** at Hickam Air Force Base, a partnership between the State of Hawaii High Technology Development Corporation and the U.S. Air Force, serves as a demonstration and evaluation site for a variety of vehicle platforms and advanced drive systems under the direction of the **Hawaii Center for Advanced Transportation Technologies (HCATT)**. HCATT programs include new fuel cell projects, expanding the fuel cell vehicle fleet and developing lithium battery powered & plug-in hybrid electric vehicles.

Since 1989, researchers at the **Electrochemical Power Systems Laboratory (EPSL)** at the **Hawaii Natural Energy Institute** of the University of Hawaii have been studying batteries and fuel cells with a focus on solid-state ionics and electrochemistry. Specific efforts include battery life prediction, hybrid power system integration and management, energy storage system field test data collection and analysis, an *in situ* diagnostic characterization of fuel cell materials, and cell degradation.

Hawaii Natural Energy Institute

8

Hawaii Center for Advanced Transportation Technologies

Another project managed for the National Demonstration Center at Hickam Air Force Base by the **Hawaii Center for Advanced Transportation Technologies (HCATT)** is the lead Air Force activity for hydrogen powered fuel cell vehicles. HCATT introduced the first fuel cell vehicles and hydrogen production & fueling station in both the Air Force and the State of Hawaii. The hydrogen production and fueling station is a uniquely designed, modular, deployable system.

The **U.S. Department of Energy** (**U.S. DOE**) promotes the vision that the transition to a hydrogen economy will begin with small-scale Distributed Generation (DG) systems. In addition to providing stationary power, these systems may also support hydrogen-fueled vehicles, and with this combination of capabilities, U.S. DOE has named these systems "Hydrogen Power Parks." The Hawaii Hydrogen Power Park, operated by the **Hawaii Natural Energy Institute**, is an integrated hydrogen energy system that measures operational results and evaluates economic performance in a real-world environment.

In 2006, the **Hawaii Renewable Hydrogen Program** was created within the **Hawaii Department of Business, Economic Development and Tourism** to support the increased use of Hawaii's indigenous renewable energy resources using hydrogen as an energy carrier. Ten million dollars was appropriated for a hydrogen investment capital special fund for program development and investment and to provide cost sharing for projects such as Hawaii's Hydrogen Power Park.

National Renewable Energy Laboratory